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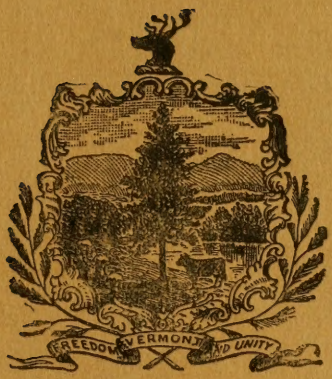

STATE OF VERMONT
Department of Fisheries and Game

A Chapter on the Artificial Propagation of the Brook Trout

BY

JOHN W. TITCOMB

Revised and amplified
February, 1915

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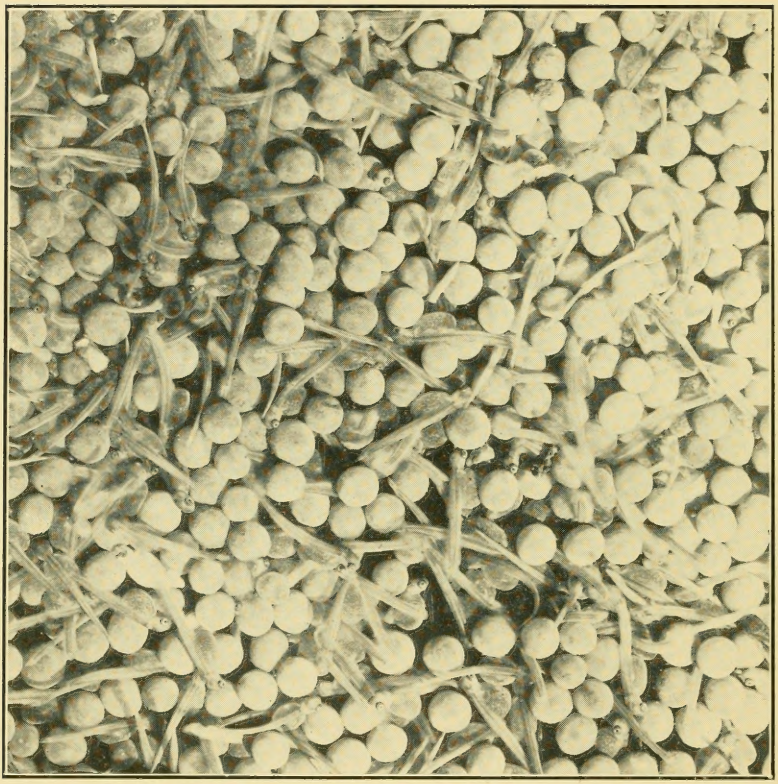


Brook trout eggs and fry as they appear on the hatching trays in the water while the eggs are in process of hatching.

As the fry hatch they drop through the wires of the tray to the bottom of the hatching trough.

FISH CULTURE.

Fish culture in the usual sense, consists in the conservation of fish eggs which would otherwise be wasted and it is made possible by the knowledge that the process in nature termed fertilization can be improved upon by manipulation. The fertilization of fish eggs may be compared to that of flowers.

The egg is to the fish what the seed is to the plant. The seed of the plant is not complete until it has been united with the pollen. Bees and other insects when in search of honey shake off the pollen and carry it from one flower to another, thus bringing it into contact with the seed, or the wind may be the agent. The milt of the fish corresponds to the pollen of the flowers and it is carried to the eggs through the agency of the water after both eggs and milt have been expelled by the parent fish. The fish culturist takes advantage of this knowledge by bringing the eggs and milt into direct contact, thus effecting almost perfect fertilization before water is applied.

There are some variations in the methods of spawntaking according to species, but in general the operation consists in expelling the eggs by a gentle pressure of the thumb and forefinger along the walls of the abdomen, the strokes being continued until all ripe eggs have been secured. The fish is usually grasped near the head, and to hold it firmly may be pressed against the body of the spawntaker. The receptacle into which the eggs are expelled is usually a 6-quart milk pan which has been dipped into the water and then emptied, thus leaving it slightly moist. The milk is obtained by the same process as the eggs, and applied to the latter in the pan used to receive them from the fish.

Heavy eggs, such as those of the trouts, are incubated in wire-bottom trays set in troughs of running water. The mesh of the wire is of size to suit the size of egg and to permit the young fish as they hatch to drop through into the trough. The troughs are usually plain open boxes varying in length from 12 to 16 feet and in depth from 4 to 12 inches, to suit conditions. An arbitrary width of 14 inches, inside measure, has been adopted, uniformity in width being desirable for economy in interior equipment.

For brook trout eggs (*Salvelinus fontinalis*) the State depends largely upon commercial trout raisers, eyed eggs being obtained from them at lower cost than it is possible to collect from wild fish at most places or from brood fish maintained only for their eggs. The eggs are annually purchased from four to six dealers. For the purpose of making a just comparison as to quality and final cost of fish produced from each purchased lot the eggs received from each dealer are accounted for until their product is ready for distribution.

[a]Eggs also are obtained from trout inhabiting natural lakes or artificial lakes on private preserves. During September and October principally and continuing into November, the fish ascend the streams in large schools on each rise of water. The fish culturist has only to provide suitable racks and traps in anticipation of the period of migration, constructing them in the streams that have been dammed to make the lakes. The fish are dipped from the trap into adjacent pens above the rack, the pens being kept covered to guard against the escape of the fish in case of a possible flood.

A field station of this character is sometimes managed by one man, who constructs the trap, rack, and pens, cares for and strips the fish, and then cares for the eggs, which are incubated until eyed, then are packed and shipped to the central station.

After the fish have been manipulated for their eggs and milt they are returned to the water with but a trivial loss if any at all.

Thus some clubs and individuals annually replenish their stock of fish by the maintenance of hatcheries in connection with their ponds.

[a] Titcomb, J. W.: Wild trout spawn; methods of collection and utility. Proceedings of the American Fisheries Society for 1897, p. 73-86.

THE BEST AND CHEAPEST METHOD OF STOCKING PRIVATE WATERS.

The scope of this article is to show how individuals may comply with the law and stock their waters at a minimum expense by procuring the eggs of trout, which can be bought at a low figure, and hatching them on their own premises.

It is hoped also that some may be interested in stocking public waters and to all such the Commission will furnish eggs free of charge.

The Financial Question.

Fry delivered in the months of April and May in small lots, cost at the rate of $2.50 to $3.00 per thousand at commercial hatcheries, most of which are located in Massachusetts and Rhode Island. The fish are either shipped by express in patent cans or sent in ordinary cans accompanied by a messenger.

10,000 fry @ $3.00 per thousand,	$30.00
Expressage, estimated,	5.00
Cost of fry at nearest R. R. Station,	$35.00

If a messenger accompanies the fish, which is the customary method, add $2.50 per day for his services; add his car fare and subsistence en route and the bill will be at least $12.00 more. The cost of fry will then amount to from $35.00 to $50.00 delivered at the railroad station.

Eggs can be bought for 50c. per thousand and expressage. Estimating the expressage at $1.50 and the total cost of 10,000 eggs is $6.50. In large lots, eggs sold as low as 35c. per thousand last season. It may be possible to obtain the eggs of the United States Fish Commission, in which case the only expense would be expressage. At the lowest estimate on the cost of 10,000 fry and the highest estimate on eggs, there is a balance of $23.50 in favor of the eggs. The eggs must now be hatched which means that you must equip yourself with a miniature hatchery and then give the

eggs care and attention a short time daily for two or three months. Two advantages of purchasing eggs, aside from the financial question, are that the product can be planted at your leisure, a few at a time, and the fish will be fresh and strong.

The cost of fingerlings is so much greater than that of fry that I have not brought them into my comparison with fry and eggs, although the results obtained by planting them are most satisfactory.

Case of eggs just opened. A single tray of eggs on the right, stacked trays of eggs in centre; ice box to the left.

In this article, I shall only give the details for procuring and hatching trout eggs, receiving the eggs in the form of "eyed ova" and conducting the work of propagation until the fry have hatched and are ready to be fed or to be planted.

With intelligent supervision in the preparation of the hatchery any boy or girl can and many will enjoy taking care of the eggs and fry until they are ready to take food.

The subject of rearing to fingerlings belongs to another chapter, when the fish require more water, more critical care and at a season when farm work demands more attention. It will be touched upon only in brief.

Water Supply.

This is the most important question to be considered both as to quantity and quality. If a hatchery is to be constructed, the water supply is the first consideration and the location of the hatchery is dependent upon it. As this article contemplates the necessity for only a small floor space to hatch enough fish to stock one stream or a portion of it, room for the hatchery may be found in the barn, barn cellar, cellar of house or some other available space protected from the inclemency of the weather. Assuming that there is floor space somewhere about your buildings, can you run your present water supply into it and have you sufficient flow of water to spare some of it for fish cultural purposes? A consideration of the following requisites will enable you to decide: First, the supply may be from a spring, a brook, a pond or a lake. Fish culturists differ as to which is preferable, but conditions vary in different localities and climates. In Vermont, very few brooks are free from sediment at all seasons. Springs, if tapped at their sources, are practically free from sediment and give an even temperature. Perhaps is would be well to make it the first condition that the water must be free from sediment. That is, it must not become roilly during the frequent thaws in winter, or the heavy rains of spring time. Second, it should be of an even temperature throughout the period of incubation. This last is not essential, but preferable. In New England, the normal temperature of spring water at the source of springs is 46 to 48 degrees and does not vary from that amount summer or winter more than five degrees. If allowed to flow along the surface until it forms into a brook, the temperature will of course be reduced in winter and raised in summer, but will be comparatively even. Trout eggs can be hatched in any temperature of spring water, or in a temperature varying from 33 to 50 degrees Fahrenheit. I prefer a temperature of from 36 to 44 degrees during the period of incubation, rising to 60 or 65 degrees for the little fishes as warm weather approaches. Ordinarily, the water supply for a house and stable is suitable for this work if a sufficient volume of it can be spared to flow steadily, 24 hours a day, for every day the hatchery is in operation. A city water supply can usually be regarded as suitable. Trout cannot be hatched successfully unless the eggs have a constant flow of water. It cannot be diverted temporarily for creamery or domestic

purposes without danger of weakening or smothering the eggs. The quantity of water depends upon the number of eggs to be hatched or the number of hatching troughs to be used. The minimum amount of water allowable for one trough whether to contain 10,000 eggs or double that number, should not be less than two gallons per minute. The simplest way of ascertaining whether there is a sufficient flow of water is to catch the flow in a pail of known measure and see how long it takes to fill the pail. If you have a spring of unknown volume, put in a temporary spout with earth packed around the intake end, long enough to conduct the water to a point where it can be caught and measured. Do not attempt to run the smallest hatchery on less than two gallons of water per minute.

It may be best to construct a small building for a hatchery near the source of supply and save piping the water. For an isolated building spring water has several advantages; it is not liable to freeze either at the intake or in the hatchery; artificial heat for the hatchery is unnecessary except for personal comfort in working over the troughs. There is one disadvantage in using spring water; the fry may develop so rapidly that they will be ready for distribution before the waters to be stocked are free from freshets.

Brook water, a considerable distance from the springs which are its source, may give trouble by freezing at the intake or still more in the troughs, unless the hatchery is artificially heated.

Water from lakes or ponds, if taken several feet below the surface, gives an even and favorable temperature for hatching eggs slowly. Do not take water from a bog or stagnant pond. Eggs and fry need air which is taken through the medium of clear, sparkling water.

The water may be conducted in pipes of lead, iron or wood, the same which are used in conducting water to your house for domestic purposes. It is preferable to use pipe two or three times larger than is absolutely necessary to give the requisite volume of water and the following statement may be used as a guide as to the size of pipe required:—"A straight cylindrical pipe, one inch in diameter, inclined one foot in ten, will convey about eleven gallons of water per minute. The same pipe, with an inclination of one foot in twenty, will convey eight gallons per minute; with an

inclination of one in fifty, five gallons per minute; with an inclination of one in one thousand, one gallon per minute. A two inch pipe will convey about 5½ times as much water as a one inch pipe; a three inch pipe nearly fifteen times as much." Angles or bends in the pipe, will materially reduce the capacity. A square conduit, made of boards or planks well jointed, does as well as anything else to conduct water, and if spring water, it may be laid on the surface of the ground, reducing the temperature slightly to its advantage. A perforated zinc or copper strainer with much more surface than the size of the conduit is preferable for the intake, but an ordinary packing box perforated with small holes and connected with the conduit will do. Any spring should be thoroughly cleaned out before the water is conducted to a hatchery and cleaned before each hatching season. It should also be covered sufficiently to exclude falling leaves and debris of any kind. The intake should be examined occasionally to guard against its becoming clogged.

While not essential, it is desirable to have the hatching room well lighted to avoid the necessity of using artificial light in working over the eggs or fry. No artificial heat is necessary in a hatchery supplied with spring water, but if the water gets below 36 degrees in temperature, artificial heat may be necessary to prevert its freezing over the surface in the troughs. There is no objection to artificial heat so far as the eggs are concerned.

In selecting a site for a hatchery, place it far enough from the intake to secure a fall of five or more feet to the floor of the building. The object of this is to raise the troughs about two feet from the floor for convenience in working over them. Bear in mind the heavy snows of winter and high waters, that the building may not be inundated.

Hatchery Building.

A simple house may be built at small expense with a plain shed roof. Use rough boards, and cover joints with 3 inch by 1 inch battens. A suitable building paper will of course make it less susceptible to changes in the weather. The roof should be made water tight. There should be a drain underneath the building to conduct the water from the waste pipes. The outside should be well drained around the bottom. A building 16 ft. by 9 ft. will accommodate a pair of troughs 12 ft. long placed side by side in the center and one additional trough against the walls on each side.

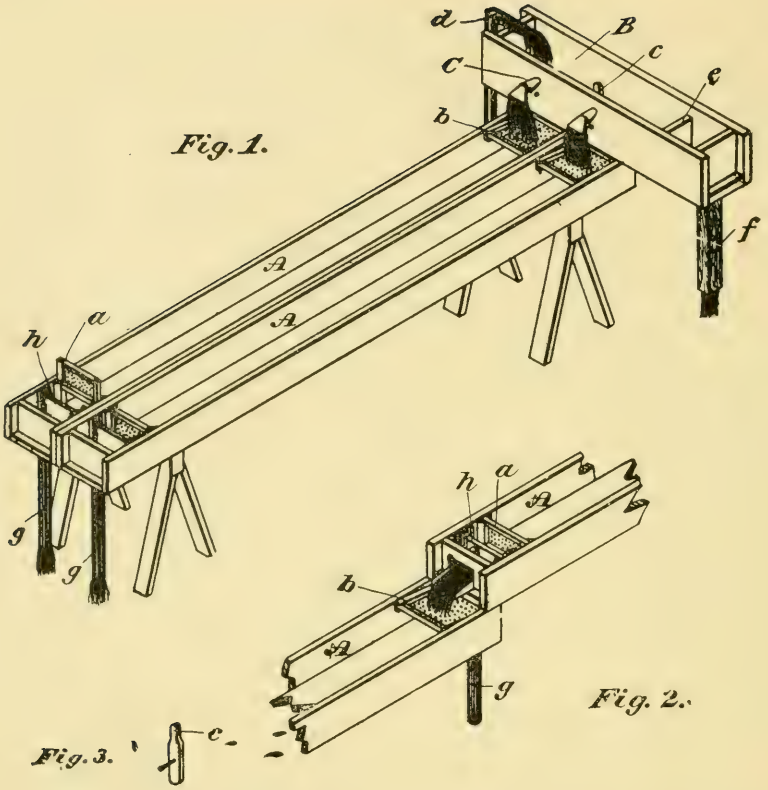


Figure 1. *A A, Hatching troughs. B, Supply trough. C, Spigot. a, Tail screen. b, Aerating screen. c, Water gate. d, Supply pipe. e, Surplus water overflow. f, Waste pipe water trough. g g, Waste pipe to hatching troughs. h, Slash board.*

Figure 2. *Sections of troughs, A A, set tandem. Figure* 3. *Water gate.*

Equipment.

Figure 1 shows the arrangement of troughs in pairs, side by side. Figure 2 shows how the troughs could be arranged so that the second trough would utilize the same water as the first one. In large hatcheries the troughs are frequently set in pairs, each pair emptying into a second pair to economize water and space. These troughs can be made of any good sound lumber; pine is preferable. If there is to be but one or two troughs, the supply trough, B, can be made out of half a kerosene barrel, burned out,

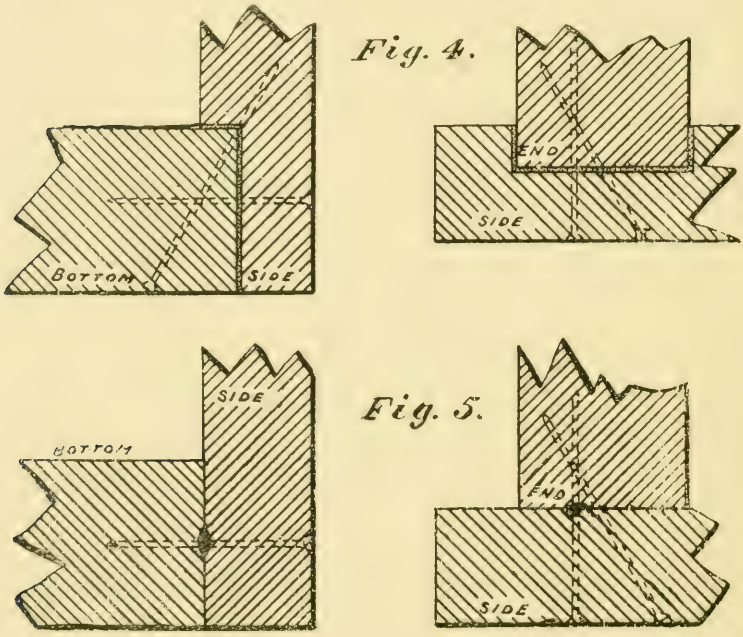
with spigots inserted the same as in supply trough, figure 1. The supply trough should be arranged with an overflow to carry off surplus water as in an ordinary watering trough or by a dam, e, figure 1, the upper edge of which is one inch below the top of the supply trough. To regulate the supply of water flowing into the hatching troughs a simple arrangement is shown in the water gate, c, and figure 3. Make the waste pipe, f, larger than the supply pipe. If this waste pipe is extended through the bottom of the supply trough to within an inch of the top it will take the place of the dam, e. The plan shown in figure 1 is designed to show a more elaborate supply trough which can be extended indefinitely, until it embraces a series of hatching troughs. Make the supply trough six inches longer than the combined widths of the hatching troughs, allowing four feet for aisle space between each pair of troughs. If only one pair of hatching troughs are to be set up side by side, the combined width of which is 30 inches, make the supply trough 36 inches long. If a second set of troughs are to be set up the supply trough should be 9 ft. 6 inches over all. It should be 10 or 12 inches wide and not less than 10 inches deep.

Bore the spigot holes 6 inches from the bottom of the trough and see that the centers of all spigot holes are in line. The supply trough should be set perfectly level and then if the spigot holes have been bored to a line, a uniform flow may be expected from each spigot.

Two Methods of Making Water Tight Joints.

To secure a water tight joint in the troughs, I suggest one of the methods shown in figures 4 and 5. The best but more expensive method is by gaining the pieces together as shown in figure 4. If no mill is accessible with suitable machinery for doing the work, the method shown in figures 5 is recommended. The stock having been cut to the exact dimensions required to build the troughs, the edges are to be grooved by depressing the wood instead of having it cut out. A tool can be made for this purpose out of a piece of heavy sheet iron $\frac{1}{8}$ to 3-16 of an inch thick and 6 inches long, then rounding one edge with a file. To depress the groove, drive the round edge of the grooving tool into the central line of the edges about $\frac{1}{8}$ inch deep. Having made all the grooves, put the trough together, inserting into the grooves, a string of round

wicking, dipped in lead paint. The wicking can be dispensed with by getting out the stock about $\frac{1}{8}$ inch wider and then groove as above. Plane off the grooved edge $\frac{1}{3}$ inch making it flush with the depressed portion. If there are any leaky joints, the depressed groove will swell and stop them. The method of jointing the supply trough and hatching troughs is the same. The specifications contemplate a pair of troughs made of clear pine stock for



Figures 4 and 5.

a permanent hatchery. Length of hatching troughs 12 to 16 feet. Sides to be made out of $1\frac{1}{2}$ inch stock planed on both sides. The bottom and ends can be made of $1\frac{1}{2}$ inch stock but I prefer 2 inch stock. Depth of troughs inside, 5 to 8 inches. If the fish are to be planted before they must be fed artificially, a depth of five inches is sufficient. The width of the troughs inside should be the same for all, and for economy in cutting tray cloth, make it exactly 14 inches.

Make the hole for waste pipe, g, figure 1, large enough to insert a $1\frac{1}{2}$ inch pipe. Put this 2 inches from the lower end of the trough. Two inches from the outlet pipe or four inches from the

lower end of the trough, nail two cleats vertically on each side, in which to slide the slash board or dam, h, figures 1 and 2. Eight inches from the lower end of the trough, put in two more pairs of cleats in which to slide the tail screen, a.

(Saw kerfs in the sides of the trough may be used instead of cleats in which the tail screen may slide. In this case the tail screen will not require a frame, but must be made one half inch wider than the inside width of the trough.)

Allow 1 1-8 inches space between the cleats. Make the cleats out of $\frac{5}{8}$ inches square stock. The slash board, h, is $13\frac{1}{4}$ inches long, 3 inches wide and 1 inch thick. Two additional cleats are required at the head of the trough, far enough below the edge to support the aerating screen, b, so that it will be flush with the top of the trough. If the troughs are arranged to set tandem as shown in figure 2, they are built and equipped exactly as described above except that in the head trough a plug is required for the waste pipe, h, and an outlet hole through the end of the trough is necessary. If a trough 5 in. in depth, cut out a square in the end of the trough, 4 inches wide and 3 inches deep. Make a tin lip to convey the water from the first trough to the second one. A sheet of tin from a tomato can will do for this purpose. Use lead paint under the tin before tacking it on. If the trough is more than 6 inches deep inside, I advise cutting out a hole in the end instead of notching down from the top.

I have specified wooden troughs because they can be home made. The dimensions as to width may be varied anywhere from 10 inches to 18 inches inside, to suit conditions. An inside width of 14 inches is the standard adopted by the United States Bureau of Fisheries. The length of the trough may be anywhere from 4 feet to 16 feet, but 12 feet is ordinarily the standard.

To have the bottoms run lengthwise in one solid piece is desirable. It is often possible to secure cypress lumber of proper width more easily than pine.

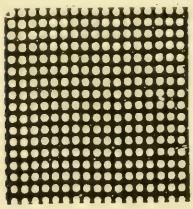
The man who is experimenting with a home made plant can use matched spruce and nail the bottom of the trough crosswise. It will not make so smooth a working surface inside but it will serve the purpose if a water tight box is thus secured.

At prevailing prices for good pine or cypress lumber, he who would buy his troughs or have them made may find it economy

to go to a manufacturer of maple sugar evaporators and sap tanks and order galvanized sheet iron troughs of dimensions herein specified. One great advantage of these is that they are sure to be water-tight, an important consideration if to be set up where it is desirable to keep the floor dry.

If sheet iron troughs are adopted, ears of the same material may be soldered to sides where saw kerfs or cleats have been suggested for the wooden trough.

Make two screens like figure 8, $13\frac{3}{4}$ inches by the depth of the trough inside. If the trough is 8 inches deep inside, make the frames of the screens 8 inches x $13\frac{3}{4}$ inches outside measure. For the upright pieces of frames, use 1 inch square stock and for the top and bottom pieces, use $\frac{5}{8}$ inch x 1 inch stock, nailing the thin sides of the top and bottom pieces to the end pieces as shown in figure 8. Cover the frames with No. 9 zinc, perforated with holes, 324 to the square inch, .033 diameter. A frame $13\frac{3}{4}$ by 8 inches, requires a piece of perforated zinc $7\frac{1}{2}$ inches by $12\frac{3}{4}$ inches.



324 holes: .033 diameter

While the perforated metal is more expensive than wire cloth it is far more durable and is more easily cleaned. If on account of expense, wire cloth is to be used for these two screens, get material described as "24 by 24, number 24 galvanized wire cloth."

For equipping a large hatchery it would be best to obtain for the aeration screens a metal with coarser perforations than for the tail screen, but in fitting up only a few troughs it will be cheaper to make the two screens alike. To the one used as a tail screen, tack two thicknesses of flannel or several thicknesses of cotton cloth on the edge which comes in contact with the bottom of the trough. This insures against escape of the alevins under the screen. If you wedge the screen on the back side as shown in figure 6 at A A, pressing it firmly down at the same time, you will secure a tight fit in the trough.

The object of the aerating screen is to spread and aerate the water and break its fall on to the fish in the trough. It also acts as a cover for that portion of the trough where it is placed.

Make the hatching trays, figure 7, $13\frac{1}{2}$ inches wide and 18 inches long, outside measure. (The length of trays may be govern-

ed by the length of troughs and with a view to economy in space.) Use for sides, pine, $\frac{7}{8}$ inch by $\frac{7}{8}$ inch and for ends, $\frac{5}{8}$ inch by $\frac{7}{8}$ inch. Mortise together as shown in figure 7. Cover with "galvanized wire cloth, 2x9 mesh. No. 24-23 double warp." For a tray $13\frac{1}{2}$ by 18, cut the cloth 13 by $17\frac{1}{2}$.

The wire cloth or perforated metals may be purchased of the Clinton Wire Cloth Co., Clinton, Mass.

The local hardware dealer, will be glad to secure prices for you from this or other sources.

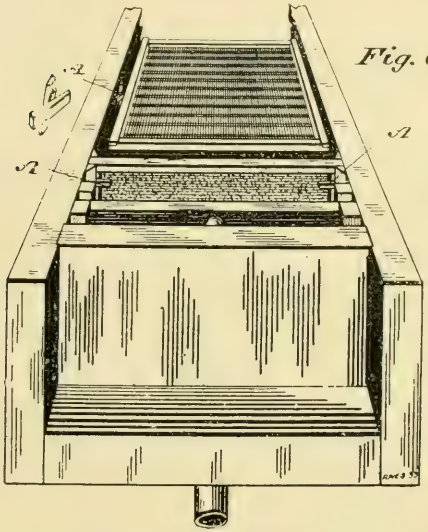


Fig. 6.

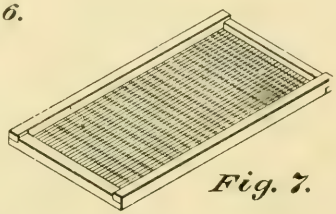


Fig. 7.

Fig. 8.

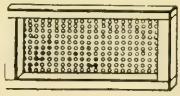


Figure 6. *Section of hatching trough, showing method of wedging a hatching tray and tail screen in place.*

Figure 7. *Hatching tray.* *Figure* 8. *Tail and aerating screens.*

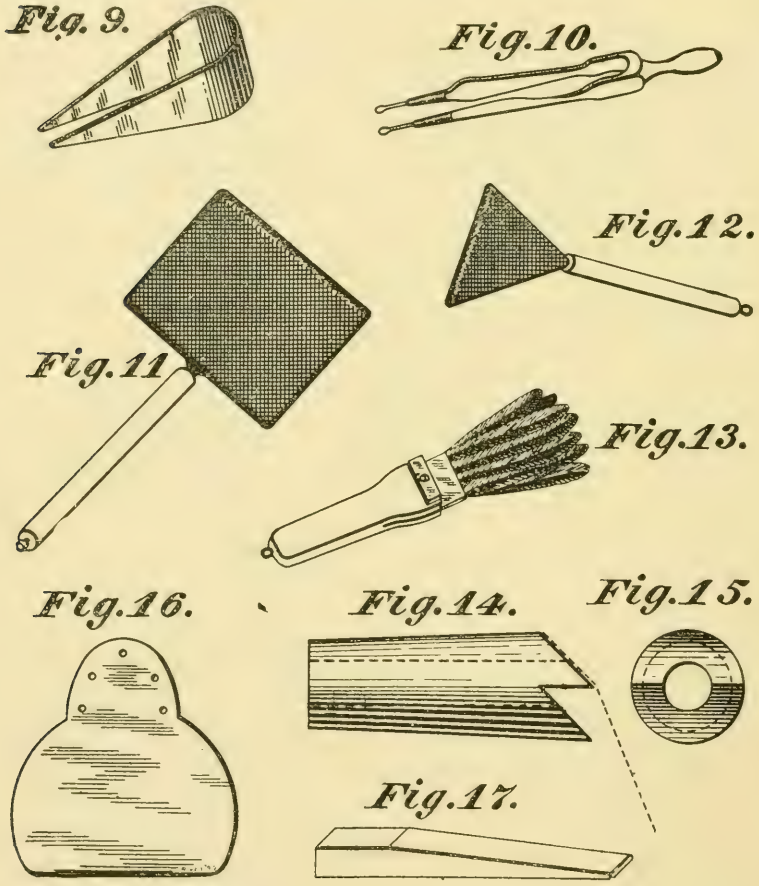
In ordering perforated metal, give the size of pieces required, in order that the stock sent you can be cut economically.

Use 3 oz. copper tacks to fasten perforated metal or wire cloth on to frames. If not easily obtainable, use 3 oz. tinned carpet tacks. Most all of the stock required in making trays and other equipment can be gotten out of the waste lumber from the troughs.

Painting.

Paint troughs inside, and all trays and other equipment which comes in contact with water, with two coats of turpentine asphaltum paint. The outsides of the troughs may be painted with turpentine asphaltum or with lead paint.

Having equipped a hatchery connected with a constant and suitable water supply, you are ready for the eggs, but there are some hatchery tools which will be convenient, most of which you can make yourself. Figures 9 and 10 show two forms of egg pickers with which to pick out dead eggs. Figure 9 is made by taking a piece of galvanized sheet iron about 22 gauge and cutting



Figures 9 *and* 10, *Egg Pickers. Figures* 11 *and* 12, *Scarf Nets. Figure* 13, *Feather Brush. Figure* 14, *Side view of Spigot. Figure* 15, *End view of Spigot. Figure* 16, *Tin Hood for Spigot. Figure* 17, *Wedge.*

it into a strip about 12 inches long, 1 to $1\frac{1}{2}$ inches wide at the centre and tapering to about $\frac{1}{8}$ in. wide at each end. Bring the two ends together, as shown in the figure. Figure 10 is a more elaborate form of picker made by cutting the tweezers out of a solid piece of clear pine about 6 or 7 inches long and attaching to them some fine wires with rings at the ends about $\frac{1}{8}$ inch in diameter. A more simple picker can be cut out by trimming down a clothes pin or cutting plain wooden tweezers out of a piece of pine. Nearly every fish culturist makes a picker to suit himself.

Figures 11 and 12 are scarf nets used for picking up eggs or fry and for cleaning troughs, etc. The rectangular net should be about 10 inches wide by 9 or 10 inches deep. It is made by bending a wire into the form shown, fastening the wire to a light handle and covering with mosquito netting or bobinet. The bobinet is preferable and costs from 45 to 75c. per yard, 54 inches wide. The side of the wire frame opposite the handle should first be covered with some coarse material to which the bobinet can be fastened. This is because the bobinet would wear out too quickly if sewed directly to the bottom of the frame. The triangular net, figure 12, is much smaller than the other and does not require so heavy a wire frame; either 4 or 5 inches to a side is a good dimension to follow. Otherwise, it is made by the same method as the larger one. It is well to paint the wire before covering it to prevent rusting. Figure 13 shows a feather brush made by slitting the end of a piece of wood with a fine saw, inserting tail feathers of a crow and fastening in place with a small stove bolt. The handle is about 6 inches long by $\frac{1}{2}$ in. thick, cut in the form shown. In addition to the implements shown, it is well to have some extra feathers either from the wings of a barnyard fowl or the tail feathers of a crow. A rectangular pan 14 in. by 20 in. and four inches deep, bound at the edge with wire, is a very handy implement in transferring eggs from packing trays to hatching trays and in many other ways. The sides and one end of the pan are to be perpendicular to the bottom, the other end flares like the side of an ordinary milk-pan.

The ordinary No. 2 bench brush, more commonly called in the kitchen a dust brush, and a palmetto scrub brush are convenient tools which can be purchased at the stores.

The spigot, figures 14, 15 and 16 is made as follows: Make a round plug of clear pine, $2\frac{1}{2}$ inches in diameter at one end and

tapering to $1\frac{3}{4}$ inches at the other, 6 inches long. Bore an inch hole through it horizontally. Notch as shown in figure 14. Cut a piece of tin into the form shown in figure 16, the upper portion to fit the end of the spigot as notched, the lower edge about 4 inches wide. The tin is tacked to the end of the plug, producing the effect shown at C, figure I. The tin hood can be bent forward or back to direct the flow of water on to the centre of the aeration screen. A wooden cider spigot with an inch hole would serve the same purpose.

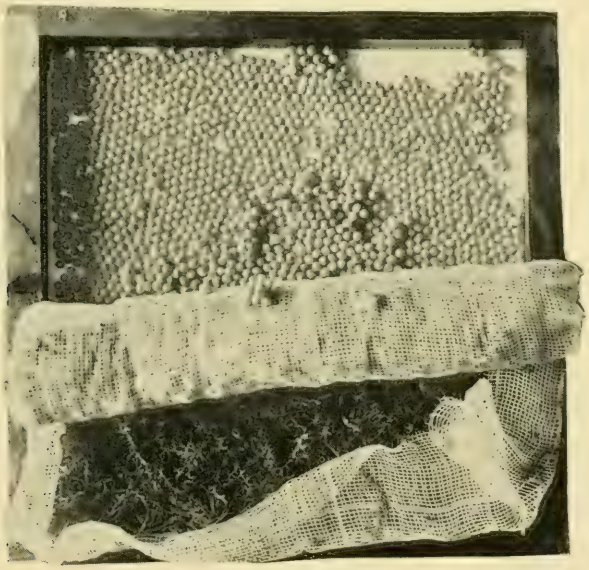
If one is willing to go to a little more expense, a one-inch molasses spigot is an improvement over the homemade wooden one herein specified. If troughs are made of galvanized iron, metal spigots in the supply trough would be almost a necessity.

Figure 17 shows a wedge. Make it out of $\frac{1}{2}$ in. square stock or dimensions approaching that size and from 4 to 5 inches long. You will need two wedges for the tail screen, two for the slash board and two for each hatching tray. The method of wedging the hatching tray so as to hold it in place above the bottom of the trough is shown in figure 6, A. By this method, the tray can be suspended at any height in the trough and is used most frequently where roily water is encountered. As water has been selected which is not going to be roily, I will describe another method of setting the hatching trays in the trough. Drive two 4d wire finish nails into the opposite corners of one end of the tray and two 6d nails into the opposite corners of the other end. Drive them in just enough to be firm and so that all four legs thus made will rest firmly on the bottom of the trough. When the tray is set in the trough, put the shorter legs towards the head of it and wedge the tray firmly into place on one or both sides. All these preparations should be made before the eggs are received. I have written quite in detail to prepare you for the reception of the eggs for it is these details which must be looked after in fish hatching and much more might be said.

How to Obtain Eggs.

These may be purchased from commercial fish culturists of whom there are many in New England. Eggs are shipped after they have been "eyed" and they are then called "eyed ova" to distinguish them from green eggs or freshly taken eggs which are

not transportable until they have arrived at a stage of development when the eye spots are visable through the shell of the eggs. Eyed trout ova can be obtained from November to February and are shipped across the continent or even to European countries without damage. The eyed eggs will come by express packed in a box of moss. The eggs themselves will be upon flannel trays covered with moss. Between the moss and the eggs is mosquito netting. Pass a dairy thermometer into the moss covering the



Tray of trout eggs showing how the cover of moss and netting is rolled away when unpacking the eggs.

eggs and see if it varies much in temperature from the water into which the eggs are to be laid down. If there is a variation of more than three or four degrees between the temperature of the eggs and the water into which they are to be introduced, drench them a few times with water in order to gradually change their temperature to that of the water. Do not be in too much of a hurry about this work. When satisfied that there is little variation between the temperature of the eggs and the water, roll back the mosquito netting with the moss in it and you have a clean tray of eggs. Hold this over the large square pan containing

hatchery water and then pour out gradually from a dipper into the tray enough water to gradually wash the eggs from the tray to the pan. Repeat this operation with the several trays until all are emptied into the pan. There will be more or less dirt and floating particles in the water with the eggs. Pour off some of the water—all that will run off without taking eggs with it. Fill the pan with water and repeat the process of pouring off water until the eggs are comparatively clean. Then, while the egg trays are floating on the surface of the water in the trough, pour out a portion of the eggs on to them. It will be well for you to have an assistant to hold the tray until you have become experienced. Shake the tray gently to distribute the eggs singly over it. Where large shipments are unpacked, it is desirable to establish a measure for each tray and then pour from the pan to the measure and then to the tray. A graduated tin dipper will do for a measure. Having filled the trays with eggs, lower each slowly into the water until its legs rest firmly on the bottom of the trough; then, while holding the tray in place with one hand, wedge it firmly with the other. The eggs can now be left until the following day, when, if there are any dead ones, they will have turned white and must be picked off. This can be done with your pickers without disturbing the other eggs on the tray. From now on until the eggs begin to hatch, I would advise picking out any dead eggs daily, although once in two or three days may do. If the eggs are neglected, a fungus growth will appear on the dead ones and quickly envelop the others. Observe the water supply every time you enter the hatchery. See that it is constant and that the eggs are not becoming covered with sediment. If there is sufficient water to flow more than two gallons per minute to a trough, flow as much as can be run without causing a current strong enough to disturb the eggs on the trays. Even if the eggs at the head of the trough are washed a little, it will do no harm during the latter stages of development. There will, of course, be no sediment because you have selected a water supply that is free from it, but, if through some unforeseen accident the eggs become coated with sediment to such an extent that you cannot distinguish the eye spots, they should be cleaned by pouring them off into the large square pan and rinsing them by the same process as when they were unpacked. A quick turn of the tray over the pan of water will empty it without the loss of an egg. Wash the

trays thoroughly before returning them to the troughs and brush out all sediment in the troughs. Use a cloth or soft brush to wash trays as the asphaltum paint is easily scratched off.

Development of Trout Eggs and Fry.

When the fry begin to hatch, they burst the shells of the eggs and emerge tail first, wriggle themselves out and pass down through the wire meshes to the bottom of the trough. As soon as all the eggs have hatched, the trays can be removed. The egg shells must be feathered out to the lower end of the trough and finally brushed out over the tail screen, care being taken not to injure or brush out fry at the same time. Cripples, deformed ones and dead from unknown causes will be picked from the trough daily by use of the small scarf net and pickers. The eggs develop first into fry with an abnormally large stomach, called the umbilical sac, which is their "bread basket". This sac is gradually absorbed until the fry appear like the one illustrated with almost no sac at all. At this period or soon after, it begins to rise to the surface of the water for food and snaps at floating particles. Unless you intend to feed the fry and rear

"fingerlings," I advise you to plant them when you see the first one develop any symptoms of hunger, or just before the sac is entirely absorbed. You will then have carried the eggs and fry through the most trying period of their existence and brought them to a suitable age to plant with fairly good results.

Transportation and Planting of Fry.

If the waters to be stocked are near the hatchery, it may be well to plant only a few each day, choosing the most active and farthest developed ones. They can be transferred from trough to pail or can on the scarf net without injury. At this stage, a

Some of the freaks which are occasionally found after the hatch. They seldom live after the yolk sac is absorbed.

third scarf net made like either of the others except that the netting should bag a trifle is useful. If attempting to stock a pond and there are any tributary streams or any springs flowing into it, plant at least a part near the springs. In stocking streams,

the same care in distributing fish should be observed, viz.: that the fry should be well scattered and placed in spring rivulets which do not dry up.

If the fish are to be transported a considerable distance, put them in clean milk cans holding about ten gallons of water for every three thousand fry. Five thousand can be carried but the less crowding the better. When the cans are not kept in motion on the cars or in the wagon, aerate the water constantly by dipping it from the can and then pouring it in again from a height of a foot or so from the top of the can. Should there be a variation of more than six or eight degrees in temperature between the water in the cans and the water in which the fry are to be planted, dip water from the can and from the stream or lake into the can until the temperature of water in the can is brought to that of the stream or lake. Do not, under any conditions, leave the can standing in the sun or allow it to sit still more than five minutes unattended. Use ice to keep the temperature at least as low as the temperature of the hatching water supply.

Conclusion.

The cost of two hatching troughs, with all necessary equipment for hatching 80,000 to 100,000 eggs should not exceed $15 or $20. The expense of constructing a hatchery building if that is necessary or of conducting a water supply to the hatchery is not included in this statement. If you wish to make only a temporary experiment, construct a trough of clear spruce boards. Use a barrel for a supply trough. Melt a couple of tomato cans and perforate one sheet of tin thus obtained for an aeration screen and cut up the other to make a lip to conduct water from the barrel to the hatching trough. Buy some good material for a tail screen and see that it fits tightly in place. You must also buy the wire cloth for hatching trays. Paint all equipment as carefully as if following the specifications for pine wood troughs of thick stock, using asphaltum paint.

40,000 eggs can be hatched with an equipment that ought not to cost more than four or five dollars after the water and protection from the weather have been provided for. There will, of course, be some loss in eggs and fry before they are planted. If the water is all right and the eggs are vigorous ones, from 80 percent to 95 percent of them should be hatched to plant as fry.

Immediately after water hardening, the careful handling of fish eggs is not injurious. During this period their numbers may be very definitely ascertained by the use of any receptacle suitable for a measure, the capacity of the receptacle having first been ascertained by counting the whole or a fractional part of its contents.

For eggs of the trouts an apothecary's graduate or the ordinary graduated quart or pint measure is commonly used. As many eggs as possible are poured into the measure, nearly all of the water being forced out over the rim

If preferable the eggs may not be measured until a more convenient time, it being possible from long familiarity with the capacity of the apparatus in actual use to estimate quite accurately the number of eggs on hand at any time. Providing they are spread uniformly, the number of eggs to a square inch is a fairly accurate basis for ascertaining how many eggs are on each tray. Some fish culturists prefer to ascertain the actual number of eggs on hand by weighing them after having determined by actual count the basis for such calculations.

These methods are especially applicable to the heavy eggs of the Salmonidae, and may be employed not only after water hardening but also at any stage of incubation after the eggs are eyed up to a day or so before hatching, at which last stage a measurement closely approximates the number of fry that will be in the subsequent hatch.

Note.—The varying usage in the classification of young fish as to size has caused such confusion and difficulty that uniform definitions have been adopted as follows:

Fry—fish up to the time the yolk sac is absorbed and feeding begins.

Advanced fry—fish from the end of the fry period until they have reached a length of 1 inch.

Fingerlings—fish between the length of 1 inch and the yearling stage, the various sizes to be designated as follows: No. 1, a fish 1 inch in length and up to 2 inches; no. 2, a fish 2 inches in length and up to 3 inches; no. 3, a fish 3 inches in length and up to 4 inches, etc.

Yearlings—fish that are one year old, but less than 2 years old from the date of hatching; these may be designated no. 1, no. 2, no. 3, etc., after the plan prescribed for fingerlings.

Sac-absorbed fry and advanced fry of the trouts, landlocked salmon, etc., may be measured in the same manner as are the eggs in an apothecary's graduate or other container, straight vertical sides being preferable to the flaring sides of the ordinary glass graduate. The ordinary graduated half-pint or pint cup used by cooks is a very convenient measure. The fry are poured in until the measure is overflowing with them to the exclusion of practically all the water, the filling and emptying being done quickly. Actual count of the number in one measure establishes the basis for computation. The growth during this period being very rapid, however, a new unit must be determined daily.

The numbers of fingerlings are ascertained by actual count of each lot as dipped a few at a time from trough to transportation can or other receptacle by means of a small hand net of tightly stretched bobinet.

Rearing Methods.

The amateur fish culturist will rarely attempt to feed and rear the fry to fingerlings. To do so requires much more care and often is attended with failure of accomplishment. To give full information on this subject would require another chapter. Briefly stated, the young fish may be confined for the first four or five months, or until 3 to 5 inches in length, in the hatching troughs or in a battery of outdoor rearing troughs of dimensions and in other respects quite similar to the indoor troughs, about 12 feet long by 14 inches wide. Care must be taken, however, to guard against overcrowding as the alevins increase in growth. The actual number of young fish of a given age which can be successfully carried is dependent upon the quality of the water supply, temperature being an important factor, not only as to the number for a given space, but also as to their rapidity in growth.

At one of the hatcheries with which I am familiar, with a supply of 10 gallons of water per minute at a temperature of about 50°, it is customary to hatch and hold in each trough 50,000 sac fry, 25,000 advanced fry, 12,500 $1\frac{1}{4}$-inch fingerlings, 4,000 $1\frac{1}{2}$-inch fingerlings, 2,000 $1\frac{3}{4}$-inch fingerlings, and 1,000 fish 2 to 3 inches in length. Much larger numbers are often

carried under similar conditions without serious loss, though often with the result that the fish prove weak in transportation.

As soon as the fry swim up looking for food they are fed several times a day an emulsion of finely ground liver. This diet is continued as the young fish develop, with the difference that the liver is less finely ground and is given less frequently—

Four trout, each about 1½ inches in length. The little fish eat their weaker brethren, necessitating frequent sorting, some growing more rapidly than others of similar age.

two or three times a day being sufficient when the fish have attained a length of 2 or 3 inches. The kind of liver used varies; that of sheep, beeves, and hogs being extensively used, and the relative value of each being in the order named. The food for the larger fish consists of the liver, lungs, and hearts of the animals already mentioned.

The emulsion is produced by running the liver through the finest obtainable plate of an Enterprise meat chopper, care being taken to first skin the liver. For the first feedings it is often desirable to run the liver through the chopper a second time.

It has sometimes been found advantageous from an economical standpoint to mix the animal food, after it has been ground, with a mush made by cooking wheat middlings or shorts, to which

a moderate amount of salt is usually added. After the mush has been thoroughly cooled the animal matter, uncooked, is stirred into it in the following proportions: For fingerlings, 1 part animal matter and 2 parts mush; for adults, 1 part animal matter and 3 parts mush. Twenty gallons of boiling water and 50 pounds of wheat middlings will make about 202 pounds of mush. The amatuer with a small number of fish will hardly care to go to this trouble, however, nor will he find it economy to do so.

The food is administered by spreading it on the surface of the water by the use of a paddle or spoon. A little water is stirred into the ground liver before it is administered

An Important Precaution.

Whenever the caretaker enters a hatchery he should first make sure there is a suitable flow of water to each trough containing fish or eggs. Second, examine the outer ends of the troughs to see if any fish are escaping. These two precautions should be a part of the daily routine.

Fish Diseases.

Absolute cleanliness is usually essential to success in carrying large numbers of fishes under artificial conditions in limited areas for various reasons because filth is often the cause of disease among fishes. The effects of fungus—saprolegnia—are usually overcome by giving the affected fishes salt baths at frequent intervals. Occasionally trout fry have been attacked by hydra in such numbers as to cause a large loss. A remedy for this trouble consists in placing the fish in a 25% vinegar solution. Whenever there is an unusual mortality among the fish or eggs the amateur should consult a fish culturist.

Artificial Ponds.

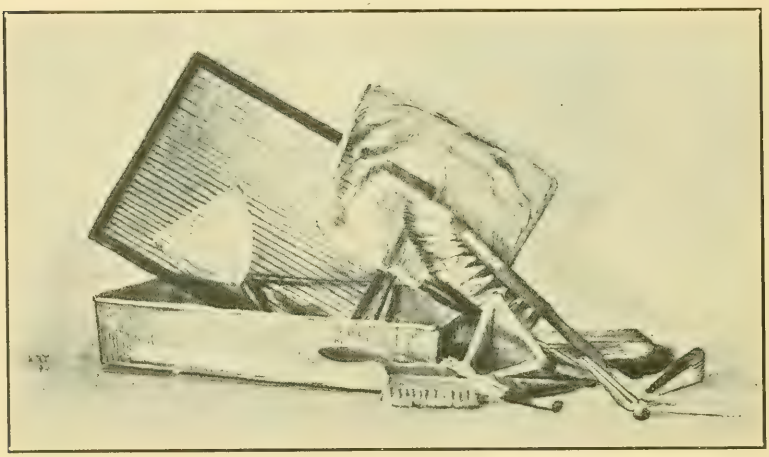
To all who contemplate the construction of ponds a few words of advice if heeded, may save money.

The area which may be flowed for a trout pond is dependent upon the volume of the water supply in times of drouth. A spring or brook when damned and thus spread over a considerable area is affected by increased evaporation with a resultant higher temperature in warm weather.

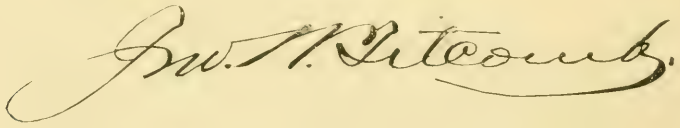
Never dam a ravine subject to freshets with the expectation of thus creating a pond in which fish will voluntarily remain or with the hopes that a screen will be effective at times of high water—when most needed.

Always construct at the lowest level of the dam a waste drain of sufficient size to draw the water within a reasonable length of time. It may never be used but in most cases will be found at some time very convenient.

Finally, if much outlay is contemplated, consult an experienced fish culturist before beginning constructions.



Shade trees and overhanging shrubs should be encouraged around the shores of ponds and along the banks of brooks as well. [a]Water plants in the ponds will come naturally in most cases but in some instances should be supplied by the transfer of a few roots from other waters.



[a] Titcomb, J. W.: Aquatic plants in pond culture. Bureau of Fisheries Document 643. 1909.

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